Asbestos in the non-mining industry on the Witwatersrand, South Africa

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Background and introduction. For many decades, and until fairly recently, asbestos was commonly found in most sectors of South African industry. Consequently there is a large but indeterminate pool of formerly exposed workers, some of whom will present to medical practitioners for evaluation of possible asbestosis, the pneumoconiosis caused by the fibre. Fundamental to the diagnosis of asbestosis is a history of asbestos exposure sufficient to cause the disease. Attending practitioners need to be aware of the common asbestosis-inducing industries and jobs and the duration of exposure reported by patients if we are to obtain and interpret their exposures. This paper describes asbestos exposure in 141 cases of asbestosis.

Methods. Cases were identified from patient records at the Occupational Medicine Clinic of the National Institute for Occupational Health (NIOH, formerly NCOH), for the years 1980 - 2000. Patients were only included in the series if they had no asbestos exposure in mining, if they had been certified with asbestosis by a compensation panel, and if on re-reading of the chest radiograph a radiologist reported irregular opacities (profusion 1/0 or greater on the International Labour Organisation (ILO) scale). Asbestos exposure was taken from the patient's records.

Results. Only one patient was exposed in an industry where asbestos was incidental to the enterprise's operation, while 54% of cases arose from exposure in primary asbestos industries, i.e. companies selling, distributing, refining, milling or using raw asbestos to manufacture products. The mean reported duration of exposure was 17.5 years. Surprisingly, 21 cases (15%) reported less than 5 years' exposure. Unexpectedly, 7 cases had a latency period from first exposure to diagnosis of less than 6 years.

Conclusion. The data presented should assist practitioners in the purposeful exploration of asbestos exposure and in interpretation of its significance with regard to asbestosis.

S Afr Med J 2005; **95:** 47-51.

South Africa has a long history of mining, transporting and using crocidolite, amosite and chrysotile — the three main commercial types of asbestos.[1] Consequently a large number of South Africans have been occupationally exposed to asbestos dust in various industries. Even though the mining of asbestos has all but ceased here (small quantities of chrysotile are still produced) and asbestos use has declined dramatically, we can expect to see asbestos-related diseases for decades to come because of the often long latency period between first exposure and disease manifestation. This long latency erases the temporal relation between exposure and disease so that the attending doctor often has to explore the patient's work history for asbestos exposure because the latter may not have made the link and may even have forgotten the contact with asbestos. It is a lot easier to get a history of asbestos exposure and to interpret its significance in relation to a specific disease if the questioner knows the asbestos disease-inducing industries and jobs, and the usual duration of exposures causing them. Despite the extent of asbestos product manufacture and use in South Africa this information has not been published for non-mining asbestosis, the pneumoconiosis (lung fibrosis) caused by the fibre. Hence this review was undertaken of the asbestos exposure of a series of patients with asbestosis diagnosed by the National Institute for Occupational Health's (NIOH, formerly NCOH) occupational medicine clinic.

The source of cases was the NIOHs occupational medicine clinic, which started in 1972.[2] The clinic is a referral point for cases of suspected occupational diseases, mainly from the Witwatersrand area of Gauteng. The study was a record review of cases diagnosed between 1980 and 2000 inclusive.

Clinic doctors submit cases of asbestosis, including doubtful ones, to a certification panel of experienced NIOH and Medical Bureau for Occupational Disease (MBOD) doctors, which certifies the case asbestosis or not for purposes of compensation processing in terms of the Compensation for Occupational Injuries and Diseases Act, 1993. In coming to a conclusion the panel of doctors consider exposure and clinical features. As is usual elsewhere, the certification panel applies the benefit of the doubt principle, so that the diagnosis is on balance of probability and not an exclusion of cases not

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satisfying pre-determined criteria.

Potential cases for this study were identified by examination of the certification panel records for the years 1980 - 2000. All 219 cases certified as asbestosis without exposure to asbestos in mining or milling on a mine were selected. Their clinic records were then retrieved and the X-ray at the time of certification was re-read by a specialist radiologist experienced in the International Labour Organisation (ILO) Classification of the Radiographs of the Pneumoconioses.[3] The radiologist knew that cases were asbestos-exposed but was blind to the occupation, duration and intensity of the exposure. Cases with X-rays read as profusion 1/0 or greater and showing type 's', 't' or 'u' small irregular basal opacities were accepted into the study. Some of these cases had associated pleural changes. Cases with missing records, unreadable X-rays or only pleural disease were excluded, leaving 141 cases for review. In summary, cases had to have a diagnosis of asbestosis by a clinic doctor, to be certified asbestosis by an experienced panel of doctors and to have had an X-ray re-read as consistent with asbestosis by an experienced radiologist. The principal author collected the following data from the records of each case: surname, first name, age, smoking history, asbestos exposure by company name, industry type, occupation, calendar years of exposure, duration of exposure, nature of exposure, panel diagnosis and percentage impairment awarded by the panel. Patients with more than one job but the same occupation in the same industry, e.g. electrician, were allocated to the single occupation group.

Industries were classified into three broad categories, based on use of asbestos. 'Primary' industry consisted of companies involved in sale and distribution of raw asbestos, milling (non-mining) or refinement of raw asbestos, and use of raw asbestos in the manufacture of products, e.g. asbestos cement products for building and construction and asbestos textiles. 'Secondary' industry included those that used asbestos products as part of the enterprise's operation, e.g. in replacement of motor vehicle brake linings, construction or insulation and fire proofing of industrial installations, e.g. in foundries and power stations. 'Tertiary' industry was where asbestos exposure was incidental to the enterprise's operation, e.g. routine maintenance of buildings (including boilers for heating) and demolition of buildings. The exposure industries are shown in Table I.

Table I. Industry category by type of enterprise

Primary industries
Asbestos cement product manufacture
Asbestos cement heating panel manufacture
Asbestos coating manufacture
Asbestos friction product manufacture
Asbestos insulation company
Warehousing asbestos
Secondary industries
Asbestos friction product user
Brick manufacture
Building and construction
Chemical
Engineering
Foundry
Furnace maintenance
Furniture manufacture (using asbestos sheets to make kitchen units)
Insulators using asbestos products
Local government
Motor vehicle maintenance
Panel beating
Pottery
Power station
Rail transport
Refractory product manufacture
Road construction
Tertiary industries
Chemical
Conveyer belt installation
Explosives manufacture
Health care
Shipping

Results

Of 219 certification panel cases identified, 141 (68%) had clinic records and readable X-rays and satisfied the asbestosis criteria. All 141 were men. Eleven medical files could not be retrieved. Twelve records had poor or unreadable X-rays. Fifty-five cases had pleural disease only and the rest (12 cases) had lung pathology other than 's', 't' or 'u' irregular opacities on chest X-ray. At diagnosis, 3 patients were younger than 40 years old, nineteen were aged 40 - 49 years, 65 were 50 - 59, and 54 were 60 or older. Eighty-seven (62%) were therefore younger than 60 years. One hundred and nineteen cases had been exposed in only 1 asbestos occupation, the remaining 22 had more than 1 occupation in which they were exposed to the fibre.

As can be seen from Tables II and III the most common occupations were machine operator, a nonspecific term for attending to a machine on a production line; general worker, used here to describe production workers who had a number of jobs in the production process, e.g. mixing and loading asbestos and cutting asbestos sheets; fitters, particularly those involved in boiler maintenance; and workers with specific jobs in asbestos product manufacture. Notably, non-production occupations such as manager and messenger in primary asbestos industries resulted in asbestosis.

Tables II and III show that only 1 man had had all his asbestos exposure exclusively in a tertiary industry. He had been a boiler attendant in a chemical factory and was exposed to asbestos from lagging (insulation) material. The records were unclear as to whether he had removed the lagging himself during boiler maintenance.

Table II. One hundred and nineteen cases of asbestosis with one asbestos-exposed occupation by industry category

Occupation	Number of workers	Industry category			Years of asbestos exposure		
		Primary	Secondary	Tertiary	Mean	Standard deviation	Min-max or total
Machine operator	16	12	4	-	12.9	10.0	1 - 29
General worker*	13	13	-	-	19.0	8.8	1 - 28
Fitter	12	3	9	-	18.8	10.7	2 - 35
Fitter: boilermaker maintenance	11	2	8	1	29.3	11.2	11 - 45
Asbestos packer	9	7	2	-	8.8	7.5	1 - 20
Asbestos mixer	7	7	-	-	17.0	9.0	5 - 30
Moulder	6	-	6	-	24.0	13.6	3 - 45
Furnace mason	6	-	6	-	22.0	9.9	6 - 34
Asbestos milling	5	4	1	-	6.0	3.7	2 - 11
Sampler	4	4	-	-	21.0	13.4	3 - 35
Carpenter	4	2	2	-	13.5	10.7	5 - 28
Fibre quality inspector	3	3	-	-	21.0	17.0	2 - 35
Builder and construction worker	2	-	2	-	10.0	5.6	6 - 14
Electrician	2	2	-	-	26.5	13.4	17 - 36
Fettling asbestos products	2	2	-	-	12.5	16.2	1 - 24
Manager	2	1	1	-	6.5	4.9	3 - 10
Messenger	2	2	-	-	19.5	0.71	19 - 20
Steam locomotive maintenance	2	-	2	-	9.5	6.4	5 - 14
Asbestos slab maker†	1	1	-	-	-	-	2
General maintenance†	1	1	-	-	-	-	36
Driver†	1	1	-	-	-	-	7
Cleaner†	1	1	-	-	-	-	1
Crane driver†	1	-	1	-	-	-	21
Turbine operator†	1	-	1	-	-	-	29
Asbestos hard waste recovery†	1	1	-	-	-	-	19
Missing information†	1	1	-	-	-	-	17
All 119 subjects	119	73	45	1	17.5	11.4	1 - 46

*General worker – workers in asbestos product manufacture with more than one job, i.e. cutter, loader, mixer, etc.
†For workers with one occupation, the total number of years of exposure is shown in the column min-max.

As shown in Table II the average duration of asbestos exposure in cases with 1 occupation was 17.5 years (range 1 - 46 years). Those with 2 or more occupations had a mean of 20.8 years with a range of 4 - 38 years (Table III). Although 67 patients (48%) had exposure of 20 or more years, 21 reported < 5 years (11 of these < 3 years), 18 had 5 - < 10 years, and 16 between 10 and < 15 years; thus 39% presented with a short history of under 15 years' exposure. Latency from first exposure to diagnosis was over 5 years for all cases: under 10 years for 3 (2.2%), > 10 - 15 for 9 (6.5%), > 15 - 20 for 11 (8%) and longer than 20 years for the rest (83.3%). Three per cent of the cases were diagnosed 50 - 69 years after their first asbestos exposure. More than 75% of the patients were exposed to asbestos dust weekly or more frequently.

The 11 cases with less than 3 years' exposure are of particular interest and their exposure history is shown in Table IV. Lung residence time (from first exposure to diagnosis) was generally long, except for case 9 who had a histological diagnosis of asbestosis. Case 10 had advanced generalised interstitial fibrosis (ILO 3/3 s/t) rather than the usual basal distribution of irregular opacities as in asbestosis. For this reason, an alternative diagnosis must be considered.

Analysis of profusion of radiological opacities showed that 43 cases had ILO profusion of 1/0 and the 38 cases were read as 1/1. The majority of cases (81/141 or 57%) therefore had low profusion scores for irregular radiological opacities (ILO 1/0 or 1/1). Eight cases were graded by the panel as having 100% respiratory impairment. There was an inconsistent relationship between panel respiratory impairment grading and profusion score. Not shown in the tables is that all 9 of the cases with the most advanced profusion (ILO 3/2 or 3/3) were exposed in a primary asbestos industry.

Discussion

The patients reaching the NIOH clinic are a selected group, although the means of selection varies. It includes cases detected by active case-finding surveys in selected enterprises and patients referred by medical practitioners seeking confirmation of the diagnosis or assistance with submission of compensation claims. Therefore it cannot be said that these cases are representative of the industries and occupations

Table III. Distribution of cases by first and second occupation, industry and total years of asbestos exposure

	Asbestos occupations			Total years of asbestos exposure
Occupation 1	Industry	Occupation 2	Industry	
Fitter	1	General worker	2	4
Fitter: boiler maintenance	1	Fitter: boiler maintenance	2	7
Fitter: boiler maintenance	2	Fitter	3	8
Carpenter	1	Machine operator	1	11
Asbestos packer	1	Asbestos mixer	1	13
Electrician	2	Machine operator	1	15
Fitter: boiler maintenance	1	Fitter: boiler maintenance	2	15
Fitter	2	Fitter: boiler maintenance	2	16
Moulder	2	Furnace mason	2	18
Asbestos hard waste recovery	1	Fitter	1	21
Fitter	3	Fitter	2	22
Furnace mason	2	Fitter: boiler maintenance	2	23
General worker	1	Smoothing heating panels	1	24
Fitter, boiler maintenance	1	Fitter: boiler maintenance	3	27
Electrician	1	Electrician	2	32
Plumber	3	Asbestos mixer	1	33
Fitter: boiler maintenance	2	Team supervisor	2	34
Furnace mason	2	Fitter	2	36
Fitter: boiler maintenance	1	Team supervisor	1	38
Fitter: boiler maintenance	2	Asbestos mixer	1	38
Builder/construction worker	2	Furnace mason	2	40
Messenger	2	Cleaner	2	46

inducing asbestosis in non-mining industry in the region. Nevertheless, the duration and latency of the exposures are unlikely to have been influenced by the selection pressures, and knowing the kind of work that produced these cases will aid practitioners in taking an occupational history.

Without a histological diagnosis we cannot be confident that all of our patients actually had asbestosis. Diagnosing the disease on clinical criteria is usual,[4] but not without error. Asbestos-exposed individuals are not immune from the many other forms of interstitial lung disease and some misclassification of diagnosis is to be expected,[5] particularly if the asbestos exposure or latency is unusually short. Inclusion criteria for cases into this series were fairly stringent, though, and the diagnosing doctors were experienced in the condition, but case 10 in Table IV must be considered doubtful.

In general, the occupations producing asbestosis were typical of those reported elsewhere. The third edition of *Occupational Lung Disorders*,[6] a standard text, lists the major historical uses of the material as the manufacture and use of asbestos-cement products, asbestos floor tiling, insulation and fire-proofing (including asbestos textiles and protective clothing), asbestos paper products and friction materials. Some of the industries producing our cases were surprising because of the past ubiquitous use of the fibre: health care (boiler maintenance),

Table IV. Asbestos exposure history for 11 patients with asbestosis with duration of exposure < 3 years

Case	Job	Years of exposure	Lung residence (years)
1	Milling asbestos	1943 - 1944	42
2	Milling asbestos	1947 - 1948	39
3	Milling asbestos	1953 - 1956	32
4	Cleaning milling area	1968 - 1969	19
5	Packing raw asbestos and cutting asbestos tubes	1977 - 1988	40
6	Packing raw asbestos	Unknown	Unknown
7	Asbestos cement slab manufacture	1954 - 1956	32
8	Quality control in friction product manufacture	1959 - 1961	34
9	Making friction products	1988 - 1990	7
10	Cutting asbestos roofing	1977 - 1978	14
11	Insulating with asbestos	Unknown	Unknown

Lung residence time = year of diagnosis minus year of first exposure.

chemical (asbestos and tar coating production), and furniture manufacture (cutting asbestos sheets for kitchen units) make the point.

Only 1 of our cases had had his only exposure in an industry in which asbestos was incidental to the enterprise's operation, testament to the fact that the disease is associated with relatively high exposure levels.[7] As a rough guide, asbestosis will not progress to clinical manifestation at or below lifetime occupational exposures of 25 fibre/ml years.[6] This estimate is equivalent to 25 years' exposure at 1 fibre/ml air concentration (a recent standard), or 5 years at 5 fibres/ml, etc. Nevertheless, it is notable in our series that managers and messengers in primary asbestos industries were at risk, presumably because of the heavy contamination of the general work environment. It should be noted, though, that cases involving environmental or domestic exposure would not have been included in this case series because the cases were sourced from a database of patients considered for compensation following occupational exposure.

Some of our patients were relatively young (15% were under 50 years) and a relatively high proportion had short duration of contact with asbestos (39% less than 15 years), but a short latency period was fairly uncommon: 7.7% reported 15 years or less. It should be borne in mind, though, that our latency period was not from first exposure to disease onset but from first exposure to presentation at the clinic, sometimes with advanced disease. Asbestosis following heavy, short-term asbestos exposure is not uncommon. For example, with as little as 1 month's contact, 20% of a cohort of amosite (brown asbestos) factory workers developed asbestosis.[8] South African asbestos miners contracting the disease after less than 5 years of service have been reported and Sluis-Cremer[9] reported that the mean duration of service in groups of North West Cape and Northern Transvaal miners coming to autopsy in the late 1960s was only 7.4 and 6.6 years respectively, although the author commented that service details were very unreliable and frequently grossly underestimated. However, the fibre residence time in the lungs from inhalation to radiological disease manifestation is usually long. The American Thoracic Society (ATS) 1986 guide on the diagnosis of non-malignant diseases related to asbestos[4] states that with levels of exposure common in the past few decades (mid-1950s to mid-1980s) the latency period between the time of exposure and the discovery of the disease is likely to be a minimum of 15 years, and more often considerably longer.

Among the explanations for our finding of younger people with short contact or residence time is that we got poor occupational histories from them. This may be true of some, but in almost all the subjects a full sequential occupational history was obtained and there were no gaps in the employment report that stretched from first job to last by calendar year. A more likely explanation in most of these cases is that asbestos exposure was very heavy. A 1988 paper on silicosis in non-mining industry on the Witwatersrand[10] found advanced disease in a series of relatively young patients, many of whom had had short exposures; the authors concluded that their findings indicate high silica levels in industry in the region.

The point these cases make is that short-term exposure with concomitant short lung residency should be expected in a small proportion of cases with asbestosis, and attending medical practitioners should not reject the diagnosis because exposure and residency were too short. In such cases asbestos exposure is likely to have been heavy and to have occurred in a job with direct and frequent contact with the fibre. Cases of short exposure and atypical clinical features should be evaluated further for other diseases.

Conclusion

The asbestos exposures reported here are valuable because although asbestos mining and use have declined dramatically in South Africa in the past decade or so, cases of asbestosis are likely to present for many years to come because of the long latency period between exposure and disease manifestation. In the main, our patients came from typical asbestosis-inducing industries and jobs but the exceptions show why a thorough occupational history is needed. Care should be taken to obtain a comprehensive history when assessing asbestos exposure, as more than 1 asbestos-exposed job is not unusual.

Short duration of occupational asbestos exposure does not exclude the diagnosis of asbestosis as the intensity of exposure may have been high or the duration underestimated. The tables can be used as a reference or important source of information when taking a medical history.

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Accepted 19 July 2004.